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EXHAUST SYSTEM FOR OPEN FRONT FIREPLACE

Background of the Invention

Field of the Invention

The present invention generally relates to heating appliances, and more particularly relates to venting systems for heating appliance combustion chambers.

Related Art

Many structures, such as residential, commercial and industrial buildings, include gas and electric appliances, such as furnaces, hot water heaters, clothes dryers, stoves, and fireplaces that produce heated products when gas/air mixtures are combusted or heat is generated. These heated products can contain waste products, such as carbon dioxide, carbon monoxide, excess heat, and/or particulates. For example, a hot water heater produces waste products such as carbon dioxide, carbon monoxide, and excess heat when heating water. An occupant could die if waste products, such as carbon monoxide, reach too high of levels within the structure. In another example, a gas or electric kitchen stove can generate unwanted heat and smoke that must be removed in order to maintain a comfortable and safe living space within the structure, while allowing make-up air to be delivered back into the structure in proper proportion to meet air quality requirements.

Appliances that produce heat by combustion often include a sealed combustion chamber to ensure that the waste combustion gases and heat are removed from the structure. Other types of heating appliances may include an open combustion chamber that is not sealed. An unsealed combustion chamber has the potential of spilling large amounts of waste products into the structure. For example, an open wood burning fireplace typically spills combustion gases into the structure at a relatively high rates at varying times (e.g., start up of the fire, when downdrafts occur in the exhaust pipe, etc.). Further, the more spread out the combustion is within the combustion

chamber (e.g., a fully lit burner plate across the combustion chamber verses a single flame in the center of the combustion chamber), the higher the likelihood that spillage will occur. Because of the safety requirements for many heating appliances, an open combustion chamber is no longer an option given these potential spillage problems.

Another consideration for current heat generating appliances is their efficiency or lack of efficiency. Many known exhaust systems do not make an efficient use of waste product heat that is collected before exhaustion of the waste products from the structure. Some appliances attempt to capture the heat being generated by moving air around the outside surfaces of the enclosure where the heating is taking place. An example air moving system an air plenum system in a fireplace or stove that uses a blower to move room air around the combustion chamber enclosure to heat the air and then discharge the heated air back into the room. Although such systems may be useful for capturing some additional heat produced by the heating device, these methods are often ineffective; resulting in much of the heat generated being discharged with the waste product outside of the structure.

The present invention addresses the increased costs and decreased efficiency associated with failing to effectively use the heat contained within waste gases generated from heat sources such as heating appliances.

Summary of the Invention

The present invention generally relates to heating appliances, and more particularly relates to a venting system for a heating appliance combustion chamber. The venting system of the present invention may be useful for venting waste products from an open front combustion chamber, promoting more efficient retention of heat generated by the heating appliance, and providing a safety system to ensure the waste products produced are not released into a living space in proximity to the heating appliance. Although the present invention may be especially useful in a heating appliance with an open front combustion chamber, many principles of the present invention may be applied to heating appliances with a sealed combustion chamber or heating source enclosure.

One aspect of the invention relates to a heating source that includes a combustion chamber, a venting assembly, and a device that draws air out of the combustion chamber. The combustion chamber enclosure includes a plurality of panels that define a combustion chamber wherein combustion occurs. The combustion chamber is open at a front surface thereof and includes a front portion that is adjacent to the front surface. The venting assembly includes spaced apart first and second panels that define a venting enclosure. The first panel defines a top panel of the combustion chamber enclosure and includes an aperture aligned with the front portion of combustion chamber. The second panel includes an exhaust opening. The vacuum device provides a vacuum pressure at the exhaust opening whereby substantially all combustion gases present in the combustion chamber are drawn through the aperture in the first panel and into the venting enclosure, and from the venting enclosure out of the exhaust opening.

Another aspect of the invention relates to a venting assembly for use with a heating source combustion chamber enclosure having a plurality of panels defining a combustion chamber for the combustion of fuel. The combustion chamber includes an open front portion for the free flow of air into the combustion chamber. The venting assembly includes first, second and third panels. The first panel is configured as a panel of the combustion chamber enclosure and includes an opening configured for the flow of fluid out from combustion chamber. The second panel includes an opening in fluid communication with the first panel opening and is spaced apart from the first panel to define a first venting chamber between the first and second panels. The third panel includes a vent pipe opening in fluid communication with the second panel opening. The third panel is spaced apart from the second panel to define a second venting chamber between the second and third panels. The opening in the first panel provides an inlet for combustion gases from the combustion chamber into the first venting chamber, the opening in the second panel provides an inlet for combustion gases from the first venting chamber into the second venting chamber, and the vent pipe

opening provides an outlet for combustion gases from the second venting chamber out of the venting assembly.

Another aspect of the invention relates to a fireplace venting assembly that is configured to vent a heating source combustion chamber. The venting assembly includes first, second and third panels. The first panel includes a first opening formed therein. The second panel includes a second opening formed therein and is spaced apart from the first panel to define a first venting chamber that is in fluid communication with the combustion chamber. The third panel includes a vent pipe opening formed therein and is spaced apart from the second panel to define a second venting chamber that is in fluid communication with the first venting chamber. The venting assembly also includes a device that is configured to provide a vacuum force at the vent pipe opening to draw air from the combustion chamber through the first and second venting chambers and out the vent pipe opening.

A further aspect of the invention relates to a method of removing combustion gases from a combustion chamber enclosure that includes a top panel, defines a combustion chamber for the combustion of fuel, and includes an open front surface for the free flow of air into the combustion chamber. The method includes forming a first opening in the top panel, the first opening providing a fluid flow path out from a front portion of the combustion chamber, positioning a housing member over the first opening, the housing member defining a venting chamber and an exhaust opening whereby fluid communication exists between the combustion chamber and the exhaust opening, and applying a suction force at the exhaust opening to draw substantially all combustion gases produced in the combustion chamber into the venting chamber and out the exhaust opening.

Another aspect of the invention relates to an air safety system for use with a heating source of the type including an open front surface for the free flow of air into and out of a combustion chamber of the heating source. The system is configured to draw substantially all combustion gases produced in the combustion chamber out of the fireplace through an exhaust opening. The safety system includes a flow sensor configured to measure fluid flow out of the exhaust opening and provide a flow signal,

and a combustion control device configured to control combustion in the combustion chamber in response to the flow signal.

The above summary of the present invention is not intended to describe each disclosed embodiment or every implementation of the present invention. Figures in the detailed description that follow more particularly exemplified embodiments of the invention. While certain embodiments will be illustrated and described, the invention is not limited to use in such embodiments.

Brief Description of the Drawings

The invention may be more completely understood in consideration of the following detailed description of various embodiments in the invention and in connection with accompanying drawings, in which:

Figure 1 is a perspective view of a fireplace that includes an open front combustion chamber enclosure and an example venting assembly according to principles of the present invention;

Figure 2 is an exploded perspective view of the fireplace shown in Figure 1;

Figure 3 is an exploded perspective view of the combustion chamber enclosure and venting assembly shown in Figure 1;

Figure 4 is a cross-sectional view of the fireplace shown in Figure 3 taken along cross-sectional indicators 4-4; and

Figure 5 illustrates the fireplace of Figure 1 coupled to a heat exchanger.

While the invention is amenable to various modifications and alternative forms, specifics thereof have been shown by way of example in the drawings and will be described in detail. It should be understood, however, that the intention is not to limit the invention to the particular embodiments described. On the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention.

Detailed Description of the Preferred Embodiment

The present invention generally relates to heating appliances, and more particularly relates to a venting system for a heating appliance. The venting system of the present invention may be useful for venting waste products from an open front combustion chamber, promoting more efficient retention of heat generated by the heating appliance, and providing a safety system to ensure the waste products produced are not released into a living space in proximity to the heating appliance. Although the present invention may be especially useful in a heating appliance with an open front combustion chamber, many principles of the present invention may be applied to heating appliances with a sealed combustion chamber or heating source enclosure.

As used herein, the term "open front fireplace" refers to any fireplace or heating appliance with an open front for the free flow of room air into the combustion chamber or other heating source enclosure of the appliance. The terms "combustion chamber enclosure" and "heating source enclosure" can be any structure that at least partially surrounds that portion of the fireplace or heating appliance in which combustion or heat generation occurs. A combustion chamber enclosure typically includes a plurality of panels that define a combustion chamber for the combustion of fuel or generation of heat using other means. The term "living space" will be understood to mean the interior or inner portion of any dwelling structure, such as a house or office building that at least partially protects from the elements. The term "outside of a living space" will be understood to mean the exterior or outer portion of a dwelling structure, which is typically exposed to various weather elements such as rain, snow, wind, etc. The term "heat exchanger" is defined as a device that exchanges heat between two separate mediums such as between separate sources of air, between air and liquid, etc.

While the example embodiments of the present invention provided below are described in conjunction with example fireplaces, the present invention is equally applicable to other fireplaces such as, for example, a direct vent, a universal vent, a B-vent, a horizontal/vertical-vent, a dual direct vent, and a multisided unit having two or three glass panels as combustion chamber side panels. Although the

present invention may be particularly useful for an open front fireplace, as described below, may principles of the present invention may be applied to closed front fireplaces, stoves, furnaces, and similar heat generating appliances.

Referring now to Figures 1 and 2, an example fireplace assembly 10 having an open front is shown and described. Fireplace assembly 10 includes a combustion chamber enclosure 12, a venting assembly 14, an outer enclosure 16, fireplace controls 18, and a burner plate assembly 20. The fireplace controls 18 are typically positioned between the outer enclosure 16 and the combustion chamber enclosure 12. The burner plate assembly 20 is typically positioned within combustion chamber enclosure 12. Venting assembly 14 is shown mounted to a top portion of the combustion chamber enclosure 12, but may, in other embodiments, be mounted to the side or rear panels of the combustion chamber enclosure 12, or be positioned merely adjacent to the combustion chamber enclosure within outer enclosure 16 rather than integral with the combustion chamber enclosure 12. Combustion chamber enclosure 12 is generally positioned within outer enclosure 16 so that the outer enclosure 16 can provide a heat barrier between the combustion chamber enclosure 12 and the structure in which the fireplace assembly 10 is installed (e.g., inside a wall of a house).

Referring now to Figures 2 and 3, the combustion chamber enclosure 12 includes a top panel 40, a bottom panel 42, a back panel 44, and first and second side panels 46, 48 that together define a front surface 50 and a combustion chamber 52. As further shown in Figure 4, combustion chamber 52 includes a front portion 54 and a rear portion 56. In the example fireplace assembly 10, combustion chamber 52 may be used for containing combustion of a solid fuel such as wood, wood pellets, corn, etc., but may also be useful for the combustion of gases or generation of heat through other means such as electric heat generation. Although a fireplace assembly is shown throughout the drawings to describe certain aspects of the present invention, the invention is not so limited to such an appliance and may be useful in other appliances that include a heat generating enclosure that is open for the free flow of air from the living space.

The venting assembly 14 is shown secured to and integral with a top portion of combustion chamber enclosure 12. Referring now to Figures 3 and 4, the top panel 40 of the combustion chamber enclosure 12 also serves as a first panel of the venting assembly; that is, a single panel defines the top panel of the combustion chamber enclosure and also serves as a first panel of the venting assembly. In other embodiments, the first panel of the venting assembly 14 may reside on top of or adjacent to the top panel 40 of the combustion chamber enclosure. The venting assembly also includes a second panel 60, a third panel 62, first and second side panels 64, 66, and front and rear panels 65, 67. Many of these panels may be formed from a single piece of material that is formed into the different individual panels. The panels may be secured together using a fastening means such as, for example, welding, fasteners, or adhesives.

Top panel 40 includes first and second sides 80, 82, front and rear portions 84, 86, and plurality of openings 88 formed across the front portion 84 between the first and second sides 80, 82. In other embodiments, the openings 88 may be replaced with a single large opening or only a few larger openings, although the grid of openings 88 shown in Figure 3 may be particularly useful for directing turbulent air flow within combustion chamber 52 into chambers of the venting assembly 14.

Second panel 60 includes first and second sides 90, 92, front and rear portions 94, 96, and a plurality of openings 98 formed across the front portion 94 between the first and second sides 90, 92. As with the openings 88 in top panel 40, the openings 98 formed and second panel 60 may be replaced with a single large opening or may be supplemented with additional side oriented openings 97, 99. The size and orientation of the openings 97-99 may have certain advantages for controlling fluid flow out of combustion chamber 52 at specific locations in the combustion chamber that are most susceptible to spillage out the front surface 50 of combustion chamber enclosure 12. For example, it is common in most combustion chambers in which heat is generated that the combustion gases and waste products produced during combustion move upward toward the top panel 40 and create turbulence as those gases hit the top panel 40. If there is not proper venting across the front portion 54 of combustion

chamber 52, these turbulent gases will begin to spill out of the combustion chamber enclosure 12, particularly near the side panels 46, 48 of the combustion chamber enclosure where it is typically least likely that sufficient venting is provided. To address this problem, the first and second side openings 97, 99 of second panel 60 are positioned adjacent to respective first and second sides 90, 92 and along front portion 94 so that maximum airflow is possible at those areas where spillage combustion chamber 52 is most likely to occur.

The third panel 62 is spaced apart from the second panel 60 and includes a vent pipe opening 69 into which a vent pipe 68 is inserted. The first and second side panels 64, 66 and front and rear panels 65, 67 extend between the third panel 62 and the top panel 40, thereby creating first and second venting chambers 61, 63 (see Figure 4). The chambers 61, 63 may provide different functions in different embodiments. In one embodiment, chamber 61 in conjunction with top panel 40 may be useful for reducing turbulence in the air flow as the air flow enters the venting assembly 14, and chamber 63 in conjunction with second panel 60 may be useful for providing air flow from certain areas of the combustion chamber (e.g., at sides 90, 92 and along front portion 94). The venting assembly design shown in Figures 1-4 may be particularly useful for creating proper flow of combustion gases out of the combustion chamber with a device that having a relatively short height. It is recognized, however, that may other embodiments are possible that provide the same, similar, or even enhanced results and that fall within principles of the invention.

Figure 4 illustrates the flow of fluids from the combustion chamber 52 into the first and second venting chamber 61, 63, and out the vent pipe 68. The rate of fluid flow through the venting assembly 14 may be measured with a flow metering device 72 positioned within vent pipe 68 through a slot 70 formed in the vent pipe. A flow signal generated by the flow metering device 72 may be directed through control line 74 to other features of the fireplace assembly 10 such as the fireplace controls 18.

The use of a flow metering device 72 provides safety advantages for at least two primary safety concerns related to open front heat heating appliances such as a fireplace. First, changes in weather conditions and sometimes pressure conditions

within the living structure may change in a way to create a back pressure in venting pipe 68, thereby slowing down or stopping the flow of combustion gases out of the combustion chamber 52. Second, when a vacuum force is applied in the venting pipe 68 with, for example, pump 142 in order to remove the combustion gases from the combustion chamber 52, venting of the combustion gases would cease if the pump 142 were to fail or run improperly in a way that reduced the vacuum force. Using the flow metering device 72, the rate of flow in vent pipe 68 is monitored and flow signals from the flow metering device may be used to control the rate of combustion in the combustion chamber so that the combustion chamber is properly vented and unsaved spillage does not occur. In the case where combustion in combustion chamber 52 cannot be automatically controlled, the flow signal may be used to stimulate a warning signal such a light or audible alarm that puts a user of the heating device on notice of the change in flow rate.

The fireplace controls 18 include a valve 130 and first and second controllers 132, 133. In the case of a gas burning fireplace, the valve 130 controls gas flow through gas line 136 to the burner plate assembly 20. The controllers 132, 133 may include a microcontroller and other electronics that manually or automatically control other features and aspects of the fireplace assembly 10. The fireplace controls 18 may be used to control the rate of combustion in combustion chamber 52 in response to the flow signal. For example, if the flow signal indicates a significant reduction in flow rate through venting assembly 14, the fireplace controls 18 may automatically shut off the burner plate assembly 20 to ensure that unwanted combustion gases and waste products generated in the combustion chamber enclosure 12 are not spilled out into the living space.

To ensure proper removal of combustion gases and other waste products from combustion chamber 52, a vacuum force is applied at vent pipe opening 69 within vent pipe 68 using, for example, blower pump 142 (see Figure 5). A heat recovery system may be particularly useful with the fireplace assembly 10 because the venting assembly 14 removes substantially all of the heat generated in the combustion chamber

52 except for some infrared heat that emanates from the burner plate and flame or other heat generating device in the combustion chamber enclosure 52.

Removing substantially all the heat from the combustion chamber 52 may have certain advantages. First, the high airflow that results from drawing substantially all of the heat and fluids from the combustion chamber 52 helps to maintain relatively low temperatures in the combustion chamber enclosure panel. For comparison purposes, known open front and closed front fireplaces typically maintain temperatures within the combustion chamber enclosure of about 400° to 1200° F depending on the nature of the heat generation and the type of heat exchange occurring between the combustion chamber enclosure and the outer enclosure. As a result of these very high temperatures, the panels of the combustion chamber enclosure also become reach temperatures in the range of 400° to 1200° F and the outer enclosure is required in order to maintain separation between the hot combustion chamber enclosure and the structure in which the fireplace assembly is mounted (such as a wall of a building that is typically susceptible to combustion). The panels of the combustion chamber enclosure 12 when used with the venting assembly 14 may maintain temperatures as low as about 120° to 200° F. Therefore, in some embodiments an outer enclosure of the fireplace assembly may not be required in order to meet the prescribed fire safety codes.

Another advantage of using the venting assembly 14 is that the heat recovery may be more accurately controlled since nearly all of the heat generated in the combustion chamber 52 is removed all of the time. The removed heat may be merely dumped outside of the living structure when, for example, the fireplace assembly 10 is being used during warm weather periods, or may be directed through a heat exchanger such as the heat recovery system 140 (see Figure 5), which typically has a heat recovery rate of about 50%. The heat recovered in the heat recovery system 140 may be directed back into the living space directly or may be directed to a central heating system or a like system that directs the heated air to other locations within the structure (as further described below).

A further advantage of using the venting assembly 14 is that the venting assembly provides an air curtain type effect across the front surface 50 of the combustion chamber enclosure as a result of the vacuum forces drawing fluids into the venting assembly 14 across the front portion 54 of the combustion chamber 52. Although the venting assembly 14 may draw significant amounts of room air from the living space in addition to the combustion gases and waste products produced in combustion chamber 52, there are no fluids from the combustion chamber that are able to spill into the living space through the front opening of the combustion chamber enclosure at the front surface 50.

A yet further advantage of using the venting assembly 14 with a fireplace or other heating appliance that has an open front is that a separate source of combustion air is not needed for combustion of fuel within combustion chamber 52. Thus, a Direct Vent or other system of providing combustion air to the combustion chamber 52 is not necessary.

The heat recovery system 140 includes a first pump 142 that draws the heated fluids removed from combustion chamber 52 through vent pipe 68 and through a plurality of heat transfer plates 146 in the heat recovery system 140, then exhausts those gases to outside the living structure. A second pump 144 draws fresh air from outside the structure or from other areas within the living space and forces the fresh air across the same plurality of heat transfer plates 146 so that the fresh air is heated. The heated fresh air is then transferred through heated air duct 146 for heating areas within the living space. Additional heat recovery systems that may be useful with the venting assembly described above are shown and described in U.S. Patent No. 6, 550,687, U.S. Patent Application Serial No. 10/339,739 filed on January 8, 2003 and entitled HEAT EXCHANGE SYSTEM, and U.S. Patent Application Serial No. 10/371,761 filed on February 24, 2003 and entitled FIREPLACE MAKEUP AIR HEAT EXCHANGE SYSTEM, which issued patent and patent applications are incorporated herein by reference in their entirety. The heated fresh air produced by heat recovery system 140 may be directed to various places within the structure as disclosed in U.S. Patent No. 6,019,099, which is also incorporated herein by reference in its entirety.

Although the venting assembly 14 is shown in the drawings as having three distinct panels that form two distinct venting chambers, alternative embodiments may include venting assemblies with only a single venting chamber defined by only two panels, wherein one of the panels may function as a panel of the combustion chamber enclosure as in venting assembly 14. Likewise, the venting assembly may include four or more panels that define three or more venting chambers. Other embodiments may include an arrangement of venting assembly panels that are not substantially parallel as are panels 40, 60, 62 (see Figure 4). For example, one or more of the panels may be oriented at a non-parallel arrangement relative to the other panels if such an orientation provides venting advantages. In yet further embodiments, the venting assembly panels are separate and distinct from panels of the combustion chamber enclosure so long as the combustion chamber enclosure is configured such that substantially all combustion gases and waste products produced in the combustion chamber can be drawn out of the combustion chamber and into the venting assembly. In still further embodiments, the fireplace assembly may include two or more separate venting assemblies associated with one or more panels of the combustion chamber enclosure.

A method of the present invention may include forming a first opening in a top panel of the combustion chamber enclosure to provide a fluid flow path out from a front portion of the combustion chamber. The method may also include positioning a housing member over the first opening, the housing member defining a venting chamber and an exhaust opening whereby fluid communication exists between the combustion chamber and the exhaust opening. The method may further include applying a suction force at the exhaust opening to draw substantially all of combustion gases produced in the combustion chamber into the venting chamber and out of the exhaust opening. Other aspects of the method may include positioning a middle panel in the housing member to divide the housing member into first and second vent chambers, the first vent chamber being in fluid communication with the opening in the top panel, and the second vent chamber being in fluid communication with the exhaust opening, the middle panel including an opening providing fluid communication between the first and second vent chambers. The method may also include aligning the

opening in the middle panel with the opening in the top panel, removing heat from the exhausted combustion gases with a heat exchanger, monitoring the flow of combustion gases out of the exhaust opening with a flow sensor and providing a flow signal, and controlling combustion in the combustion chamber in response to the flow signal.

An air safety system according to the principles of the present invention may be used with a heating source of the type including an open front surface for the free flow of air into and out of a combustion chamber of the heating source. The air safety system is configured to draw out substantially all combustion gases produced in the combustion chamber through an exhaust opening. The air safety system includes a flow sensor configured to measure fluid flow out of the exhaust opening and to provide a flow signal representative of the fluid flow, and combustion control device configured to control combustion in the combustion chamber in response to the flow signal.

Another aspect of the present invention relates to a method of extracting heat from a combustion chamber of an open front fireplace during combustion of fuel in the combustion chamber. The method may include the steps of emanating radiant heat out of the combustion chamber through the open front of the fireplace, drawing substantially all combustion gases and heated air from the combustion chamber through a venting assembly, and removing heat from the drawn combustion gases and heated air with a heat recovery device. The emanating step may also include emanating infrared heat from panels that define the combustion chamber and a burner plate assembly of the fireplace. Further, the venting assembly may also include a first opening into the combustion chamber that is oriented near a front portion of the combustion chamber, and the drawing step includes providing a vacuum force at the first opening.

The present invention should not be considered limited to the particular examples or materials described above, but rather should be understood to cover all aspects of the invention as fairly set out in the attached claims. Various modifications, equivalent processes, as well as numerous structures to which the present invention may be applicable will be readily apparent to those of skill in the art to which the present invention is directed upon review of the instant specification.